

The Genetic Parameters for Average Daily Gain and Kleiber Ratio in Charolaise Breed

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Abstract

The objective of this paper was to estimate the genetic parameters for average daily gain from 200 days to 365 days and Kleiber ratio in Charolaise breed with maternal animal model. The data were represented by 582 records of Charolaise cattle breed. The pedigree consisted in 1284 cattle: 123 sire, 579 dams and 582 cattle with performances. The data were obtained from Romanian Breeding Association for beef cattle. The direct breeding value of cattle were from -0.339 to 0.969 kg for average daily gain between 200 days and 365 days and maternal breeding value between -0.361 to 0.207. The direct breeding value of cattle for Kleiber ratio were between -0.318 and 0.678 and maternal breeding value between -0.354 and 0.205. The direct heritability for average daily gain from 200 days to 365 days was 0.570, the maternal heritability 0.183 and the total heritability 0.353. The direct heritability for Kleiber ratio was 0.414, the maternal heritability 0.201 and total heritability 0.189.

Keywords: breeding value, cattle, maternal animal model

1. Introduction

The meat production is determined by the genetic and nutrition factors. Charolais breed is a beef breed with high meat production. Charolais have growth ability, efficient feedlot gains. Charolais are good for growth and uniformity and the ability to fit into any system. The body development of cattle from Charolais breed is good, being one of the large beef breeds. Young cattle achieve great growth gains and are suitable for pasture maintenance. The Kleiber ratio can serve as an indirect indication of feed conversion efficiency, the cattle with higher breeding value are more efficient. The breeding value for average daily gains shows the genetic differences between cattle for post-weaning growth. The objective of the breeding program of the Charolais breed was

the improvement the body weight and average daily gain between birth and weaning. Charolais breed is adapted to the pedoclimatic conditions from our country. The aim of this study was the estimation the genetic parameters for average daily gain from 200 days to 365 days and Kleiber ratio in Charolaise breed with maternal animal model for selection.

2. Materials and methods

The data were represented by records of 582 cattle. The pedigree consisted in 1284 animals: 582 cattle with records, 579 dams and 123 sire from Charolaise breed. The data were from Romanian Breeding Association for beef cattle. The estimation of variance components and genetic parameters was performed based on script [1] using maternal animal model with the software R 3.5.1. The maternal animal model was (Mrode and Thompson, 2005) [2]:

$$y = Xb + Za + Wm + Spe + e$$

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where:

y = the vector of observations,
 b = the vector of the fixed effects,
 a = the vector of the random animal effects,
 m = the vector of the random maternal genetic effects,
 pe = the vector of the permanent environmental effects and
 e = the vector of the random residual effects.
 X , Z , W and S are the incidence matrices referring to animal performance, to the fixed effects, to the direct effects, the maternal effects and to the permanent environmental effects.

It is assumed that:

$$\text{var} \begin{bmatrix} a \\ m \\ pe \\ e \end{bmatrix} = \begin{bmatrix} \sigma_a^2 A & \sigma_{am} A & 0 & 0 \\ \sigma_{am} A & \sigma_m^2 A & 0 & 0 \\ 0 & 0 & I\sigma_{pe}^2 & 0 \\ 0 & 0 & 0 & I\sigma_e^2 \end{bmatrix}$$

where:

A is the kinship matrix between animals;
 I is the identity matrix;
 σ_a^2 is the additive genetic variance for the direct effects,
 σ_m^2 , the additive genetic variance for the maternal effects,
 σ_{am} , the additive genetic covariance between the direct and maternal effects,
 σ_{pe}^2 , is the variance due the permanent environmental effects,
 σ_e^2 , is the variance of the residual error.

According to the objective of this paper the following genetic parameters were estimated:

- the direct heritability $h_a^2 = \sigma_a^2 / \sigma_p^2$, where σ_p^2 is the phenotypic variance
- the maternal heritability $h_m^2 = \sigma_m^2 / \sigma_p^2$
- the covariance between direct and maternal effects as proportion of the phenotypic variance (σ_{am} / σ_p^2)
- the total heritability (Wilham et al., 1972) [3]

$$h_T^2 = \frac{\sigma_a^2 + 0.5\sigma_m^2 + 1.5\sigma_{am}}{\sigma_p^2}$$

where:

h_T^2 is the total heritability, and σ_p^2 is the phenotypic variance.

The Kleiber ratio at 200 days was estimated with formula:

$$KR_i = ADG/BW^{0.75} * 100$$

where:

ADG= average daily gain observed between weight at 200 days and weight at 365 days
 BW= the body weight at 365 days.

3. Results and discussion

In Table 1 the statistics for weight at 200 days, weight at 365 days, average daily gain between 200 days and 365 days and Kleiber ratio for Charolaise cattle were presented.

The average daily gain in beef cattle is influenced by breed, population, individual.

The average daily gain of calves from weaning (at 200 days) to 365 days and Kleiber ratio from our study were lower than the average daily gain between 210 days and 365 days (1.050 kg) and Kleiber ratio (1.15) obtained in Charolais breed and in Limousine breed (1.060 kg, respectively 1.14) by Rezende et al. (2022) [4]. The metabolic live weight at 365 days of age was 90.72 kg in Charolais breed and 91.91 kg in Limousine breed (Rezende et al., 2022) [4]. Matos et al. (2018) [5] reported the weight at 365 days 273.79 kg in Brahman cattle breed and the average weight gain from 205 days to 365 days 0.42 kg and Kleiber ratio at 365 days 0.61. Mehrban et al. (2021) [6] reported the mean for average daily gain 874.34 g and for Kleiber ratio 9.78 (g/kg) in Hanwoo beef cattle. The body weight was recorded at 6, 12, 18 and 24 months, the average daily gain was estimate with linear regression. The mean of mid test metabolic body weight was 86.68 kg.

Table 1. The descriptive statistics for the studied traits

Trait	Mean ±SE	SD	CV (%)
Weight at 200 days (kg)	216.238±1.75	42.24	19.53
Weight at 365 days	366.766±2.27	54.96	14.98
Average daily gain (kg/day)	0.912±0.0103	0.249	27.32
Kleiber ratio (kg/kg ^{0.75})	1.084±0.009	0.223	20.615
Metabolic live weight at 200 days (kg)	83.635±0.388	9.369	11.202

In Table 2 the statistics for average daily gain and Kleiber ratio for females and males were shown.

In Table 3 were presented the direct breeding values for average daily gain and Kleiber ratio for the best cattle.

Table 2. The average performances for average daily gain and Kleiber ratio for females and males

Trait	Mean ±SE	SD	CV (%)
Average daily gain for females (kg/day) 200-365 days	0.925±0.012	0.25	27.935
Average daily gain for males (kg/day) 200-365 days	0.883±0.016	0.225	25.568
Kleiber ratio for females	1.097±0.011	0.23	21.146
Kleiber ratio for males	1.056±0.014	0.20	19.107

Table 3. The direct breeding value of the best cattle for average daily gain and Kleiber ratio in Charolais breed

No.	Direct Breeding value of cattle for Average daily gain (kg)	Direct breeding value of cattle for Kleiber ratio
1	0.969	0.678
2	0.911	0.630
3	0.814	0.491
4	0.705	0.487
5	0.623	0.473
6	0.616	0.463
7	0.606	0.458
8	0.605	0.427
9	0.605	0.419
10	0.553	0.409

In the Table 4 the maternal breeding values for the best cattle for average daily gain and Kleiber ratio were presented. Koster et al. (1994) [7] reported the heritability for Kleiber ratio for growth from 205 days to 365 days, 0.225 in Hereford cattle. Khobondo et al. (2022) [8] reported the direct heritability for ADG 205-365 days 0.12 and for Kleiber ratio at 365 days 0.26.

In the Table 5 were presented the genetic correlation between direct and maternal breeding value for two traits. Bergh et al. (1992) [9] reported the heritability for average daily gain between 140 days and 400 days 0.48 and for Kleiber ratio 0.52.

The genetic correlation between average daily gain and Kleiber ratio was 0.991 (Table 6). Schoeman and Jordan (1999) [10] reported the mean for average daily gain from weaning to 17.4 months in multibreed synthetic beef 0.88 kg and for post-weaning Kleiber ratio (KR*10⁴) the mean

was 85. The direct heritability for post-weaning Kleiber was 0.16 and maternal heritability 0.03.

Table 4. The maternal breeding value of the best cattle for average daily gain and Kleiber ratio in Charolais breed

No.	Maternal breeding value of cattle for average daily gain (kg)	Maternal breeding value of cattle for Kleiber ratio
1	0.2076	0.2059
2	0.1432	0.1822
3	0.1366	0.1663
4	0.1302	0.1580
5	0.1263	0.1434
6	0.1234	0.1311
7	0.123	0.1276
8	0.1214	0.1236
9	0.1179	0.1235
10	0.1154	0.1232

Table 5. Estimates of (co)variance components and genetic parameters for average daily gain and Kleiber ratio for Charolais cattle breed

Item	Average daily gain	Kleiber ratio
σ^2_a	0.0254	0.0193
σ^2_m	0.0081	0.0093
σ_{am}	-0.0091	-0.0101
σ^2_{pe}	0.0175	0.0252
σ_e^2	0.0026	0.0028
σ_p^2	0.0445	0.0466
c^2	0.3932	0.5407
σ_{am}/σ_p^2	-0.2056	-0.2167
h_a^2	0.570	0.414
h_m^2	0.183	0.201
r_{am}	-0.636	-0.752
h_T^2	0.353	0.189

Rezende et al. (2022) [4] obtained the direct heritability higher than in our study for Kleiber ratio at 365 days 0.44 and maternal heritability 0.17 lower than in our study in Charolais breed and 0.41 respectively 0.13 in Limousine breed. Matos et al. (2019) [5] reported heritability for Kleiber ratio at 365 days 0.26.

Table 6. The genetic correlation for average daily gain and Kleiber ratio

Item	The genetic correlation between direct breeding values	The genetic correlation between maternal breeding values
Average daily gain vs. Kleiber ratio	0.991	0.995

4. Conclusions

In the Charolais breed the heritability for average daily gain from 200 days to 365 and Kleiber ratio was high. The genetic correlation between direct breeding values of cattle and maternal breeding values for average daily gain and Kleiber ratio was very high. For improvement the meat production and feed efficiency the selection of the cattle for average daily gain and Kleiber it is necessary in Charolaise population.

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